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STUDY TITLE: Digital High Resolution Acoustic Data for Improved Benthic Habitat/Geohazard Evaluations

REPORT TITLE: Improved Geohazards and Benthic Habitat Evaluations: Digital Acoustic Data with Ground Truth Calibrations

CONTRACT NUMBER: 14-35-0001-30660-19910

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Central Gulf of Mexico

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CUMULATIVE PROJECT COST: $392,534

PROJECT MANAGER: H. H. Roberts

AFFILIATION: Louisiana State University, Coastal Studies Institute

ADDRESS: Howe/Russell Geoscience Complex, Baton Rouge, LA 70803

PRINCIPAL INVESTIGATOR: Harry H. Roberts, Ph.D.

KEY WORDS: Geohazards; hydrocarbon seepage; chemosynthetic communities; high resolution acoustic data; 3D-seismic surface attribute data

BACKGROUND: Hydrocarbon exploration and production activities are taking place in a dynamic and complex geologic framework for the northern Gulf of Mexico continental slope, which is inherited from the interplay of massive sediment input since Cretaceous times and the compensating movement of allochthonous Jurassic salt. The end product is perhaps the most geologically and ecologically complex continental slope setting in today's oceans. Therefore, it becomes important for basic science, applied science, and regulatory reasons to develop a better understanding of slope processes and seabed characteristics in this province where "ground truth" data are scattered and have been collected primarily for site-specific reasons. In order to effectively manage OCS activities, MMS must incorporate the best possible information from industry and academia to develop new concepts and technologies for environmental assessment. It is in this spirit that this study was undertaken in order to provide criteria and concepts for improved interpretation of sea floor geology and habitats of sensitive benthic communities.

OBJECTIVE(S): The objective of this study is to apply state-of-the-art digital acoustic data, both high resolution seismic and lower resolution, but deeper penetrating 3D-seismic as well as side-scan sonar data, for developing a conceptual framework and reliable criteria for identification of sea floor features and areas that are the products of hydrocarbon venting-seepage. Within this overall aim of the study a parallel purpose is to better understand how to interpret the presence or absence of chemosynthetic communities from standard high-resolution acoustic data collected for geohazards evaluation and 3D-seismic surface amplitude data.

DESCRIPTION: The intent of this program is to use both digital and analog high resolution acoustic data sets (geohazards data) as the primary data sources with digital 3D-seismic surface attribute data as an added source of interpretive information and direct observation-sampling by research submersible for sea floor verification. As this program has progressed, it has become absolutely clear that the sea floor verification step is necessary on multiple examples within each feature category before reliable interpretation criteria can be developed. In addition, sea floor attribute mapping from 3D-seismic data has added a new dimension that provides a means of mapping gas in surface sediments and the presence of hard mineralized bottoms. Combined with high resolution acoustic data sets and sea floor verification data, the surficial information provided by 3D-seismic makes a powerful combination for interpreting sea floor geology and thereby benthic habitats.

Many sea floor features such as faults and submarine landslides plus other forms of mass movement are relatively easy to identify even on mediocre acoustic data sets. There are however, many sea floor features that morphologically range from mounds to depressions that represent themselves on high-resolution seismic profiles as acoustic wipeout zones or zones of no organized subsurface reflection horizons. These features present a particularly difficult problem for those tasked with interpreting sea floor geology from remotely sensed high and medium resolution acoustic data. Most interpreters consider acoustic wipeout zones to be the product of bubble phase gas in surface and shallow subsurface sediments. Previous studies, which have incorporated ground-truth verification of zones of no acoustic return through cores and direct observations using an ROV or manned submersible, demonstrate that acoustic wipeout zones can be associated with many different types of features and sea floor types. They range from mud volcanoes to mud mounds containing gas hydrates to areas of lithified sea floor and extinct expulsion sites. Through manned submersible inspection of these sea floor types and features that have acoustically turbid interiors, it has been determined that most of them are the products of fluid and gas expulsion. Liquid and gaseous hydrocarbons are commonly found associated with acoustic wipeout zones, and the presence of chemosynthetic organisms is common but not absolute. So, the challenge becomes one of definitive identification of various types of sea floor features that have a common general response on high-resolution seismic data sets. The establishment of reliable interpretation criteria coupled to digitally acquired data has the potential to greatly increase the reliability of geohazards evaluations suitable for compliance with MMS regulations for chemosynthetic communities without the added expense of bottom video and/or photographic survey.

SIGNIFICANT CONCLUSIONS: Areas of continental slope seafloor impacted by hydrocarbon venting and seepage are nearly always represented on high resolution seismic profiles as acoustic wipe-out zones. Through an appraisal of the variability of seafloor features within areas characterized by acoustic wipe-out zones plus fluid and gas expulsion, feature types can be conveniently grouped into those that are the result of rapid delivery of fluids and gases at one end of the spectrum to those that are the result of slow seepage on the other. Mud-prone features such as mud vents, mudflows, and mud volcanoes do not generally support complex chemosynthetic communities, and hydrocarbons reaching the seafloor are only slightly biodegraded. Mineral-prone features such as mounded carbonates, hardgrounds, or barite-carbonate-encrusted areas also do not support densely populated and complex chemosynthetic communities.

STUDY RESULTS: During the course of this project detailed data sets were collected on 29 features of the northern Gulf of Mexico upper continental slope (<1000 m water depth). A shallow subsurface acoustic wipeout zone on high resolution seismic represented each one of these sites. In addition to high resolution seismic, side-scan sonar, 3D-seismic, and direct seafloor verification data sets were analyzed for each feature and a synthesis of feature characteristics derived. Utilization of 3D-seismic surface amplitude and phase data provides a powerful additional element for interpreting seafloor geology and, to some extent, biology when used in conjunction with good quality high-resolution seismic and side-scan sonar data. The quality of interpretation of seafloor geology using remotely sensed acoustic data is dependent on a wide variety of variables, including frequency and firing rate of the source, towing configuration, filtering, and recording-data storage modes. This program has led to an improved understanding of hydrocarbon seep/vent-related phenomena on the Louisiana-Texas continental slope by helping clarify the relationships between rate of delivery of fluids and gases to the seafloor and geologic as well as biologic response.

STUDY PRODUCT(S): Roberts, H.H. 2001. Improved geohazards and benthic habitat evaluations: digital acoustic data with ground truth calibrations. OCS Study MMS 2001-050. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, La. 179 pp.

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